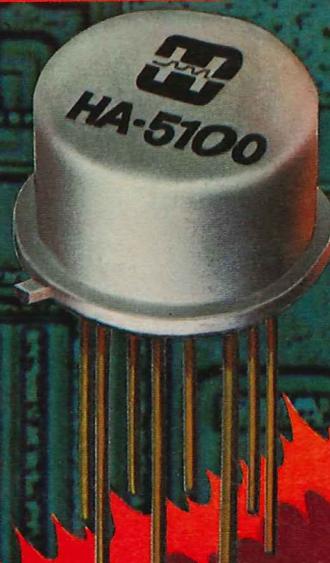


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HARRIS HIGH PERFORMANCE OPERATIONAL AMPLIFIERS PRODUCTS GUIDE

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INTRODUCTION

Harris Semiconductor is a leading manufacturer of integrated circuits, offering a broad line of analog and digital products. Our analog products, including operational amplifiers described in this catalog, are recognized for their high performance and high reliability throughout the industry.

High performance is the hallmark of the Harris Semiconductor operational amplifier line, which offers a level of dynamic performance not readily available elsewhere.

Harris has been an innovative producer of analog integrated circuits, consistently offering new products representing the leading edge of technology. This innovative spirit, coupled with strong engineering and processing capabilities, enables Harris to offer the high-performance

products listed in this catalog.

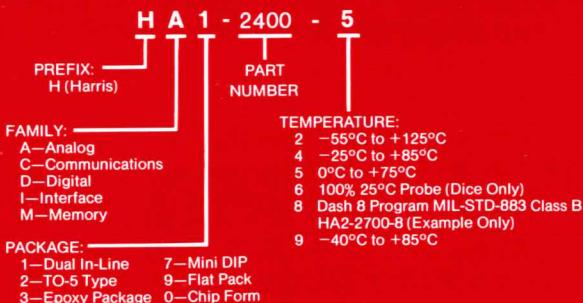
Most Harris operational amplifiers employ a dielectric (DI) process (see facing page), resulting in important performance advantages over competitive products. Some of these advantages include faster speeds and latch-free operation, as required for the precise amplification of signals in all types of applications—military, aerospace/avionics, industrial process control, instrumentation and others.

This short form catalog is intended to provide a list of all operational amplifier products available from Harris Semiconductor. Only the more important specifications are included. For complete information, including prices, contact the appropriate sales office listed in the back of this catalog.

ORDERING INFORMATION

Harris products are designated by "Product Code." When ordering, please refer to products by the full code. Harris products will always begin with the letter H. Specific device numbers will always be isolated by hyphens.

PRODUCT CODE EXAMPLE



Harris Semiconductor products are sold by description only. Harris reserves the right to make changes in circuit design, specifications and other information at anytime without prior notice.

HARRIS DASH 8 PROGRAM

The Harris DASH 8 Program makes readily available many high reliability products for "off-the-shelf" delivery. Parts screened to MIL-STD-883 Method 5004, Class B, are branded with the postscript "-8."

SPECIAL ORDERS

For best price and availability, specify Harris standard "Product Code" devices, available worldwide from authorized Harris distributors. For enhanced reliability, ask for "Dash 8" screening; consult Harris application engineers for suitability of a part for a given application. For additional guarantees or screening, submit a Request for Quotation and Source Control Drawing to your local Harris Sales Office or Sales Representative.

DIELECTRIC ISOLATION

The exclusive Harris Dielectric Isolation (DI) process is particularly advantageous for fabricating high-performance analog ICs, such as Harris Op Amps.

In the DI process, each active area is surrounded on the sides and bottom by an insulating layer of silicon dioxide, and imbedded in polycrystalline silicon.

This process for bipolar ICs begins with a wafer of N-type silicon. The side of the wafer which will eventually be the bottom is deeply etched to form the sidewall pattern. Silicon dioxide and polycrystalline silicon are then grown to fill the etched "moats."

The opposite side of the wafer is then polished until the insulating sidewalls appear at the wafer surface (see Figure 1). Conventional diffusion and metallization processes follow, to complete the IC.

DIELECTRIC ISOLATION ADVANTAGES

Dielectric Isolation for analog ICs has a number of advantages:

1. Almost all Op Amp designs require at least one PNP transistor in the signal path. Typical JI Op Amps must use a lateral PNP which inherently has very low frequency response,

limiting typical compensated bandwidth to 1 MHz. The DI process makes it practical to build a vertical PNP with much higher bandwidth, making possible bandwidths to greater than 100 MHz (see Figure 2).

Also, transistor collector-to-substrate capacitances are reduced by a factor of three as compared to equivalent JI devices, further enhancing high frequency performance.

2. Other devices, such as optimally specified MOS or JFET transistors, may be fabricated on the same chip. Isolated diffused and thin-film resistors are also practical.

3. The isolation removes the possibility of parasitic SCRs, which might create latchup under certain sequences of power and signal application.

4. Leakage currents to the substrate under high temperature conditions are greatly reduced. While the circuits in this catalog were not specifically designed for operating temperatures greater than +125°C, many have shown superior performance.

For ICs requiring the ultimate in radiation resistance, consult Harris Semiconductor's Programs Division.

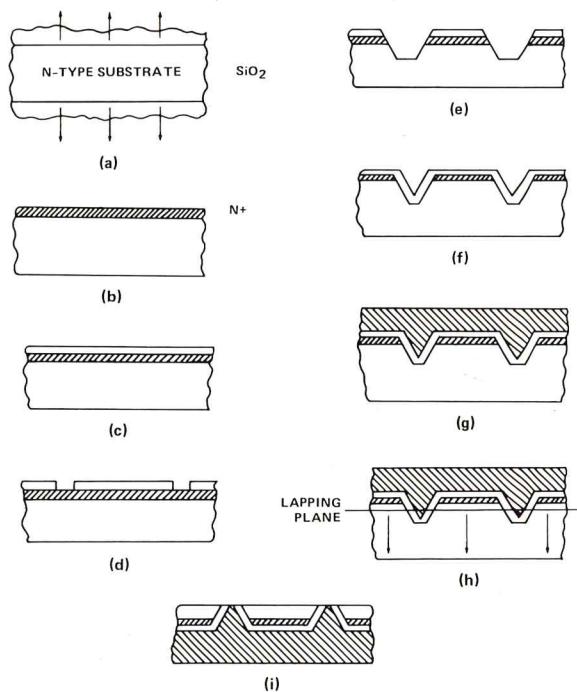


Figure 1. Process steps for Dielectric Isolation:
(a) Surface preparation, (b) N-buried layer diffusion,
(c) masking oxide, (d) isolation pattern, (e) silicon etch,
(f) dielectric oxide, (g) polycrystalline deposition,
(h) backlap and polish, (i) finished slice.

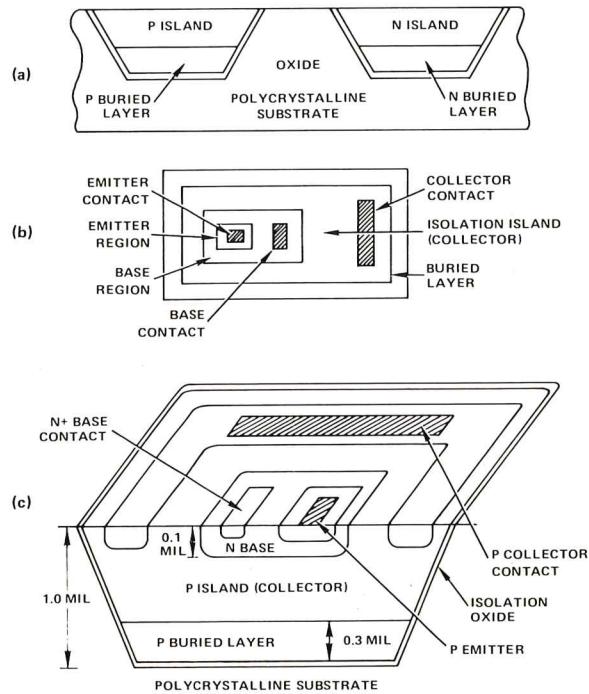


Figure 2. The high frequency process: (a) Cross-sectional view of P and N islands for PNP and NPN transistors;
(b) Topological view, showing relative placement of transistor regions;
(c) Cross-sectional view of high-frequency PNP device formation in the DI process.

SINGLES

HA-2500 PRECISION HIGH SLEW RATE OPERATIONAL AMPLIFIERS

The Harris HA-2500/2510/2520 series of monolithic operational amplifiers offer an unsurpassed combination of specifications for slew rate, bandwidth and settling time.

In addition to their excellent dynamic characteristics, these dielectrically isolated amplifiers feature low offset voltages, low offset currents and high input impedance.

All amplifiers in this series—HA-2500 through

HA-2527—are available in the TO-99 can, 8-pin dual-in-line ceramic, or 8-pin dual-in-line epoxy packages.

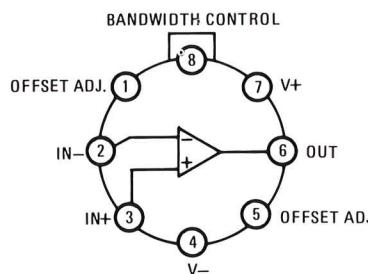
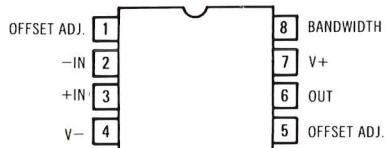
APPLICATIONS

- Data Acquisition Systems
- RF Amplifiers
- Video Amplifiers
- Signal Generators
- Pulse Amplification

PERFORMANCE FEATURES	HA-2500, HA-2502, HA-2505, HA-2507	HA-2510, HA-2512, HA-2515, HA-2517	HA-2520, HA-2522, HA-2525, HA-2527
HIGH SLEW RATE	30 V/ μ s	60 V/ μ s	120 V/ μ s
FAST SETTLING	330 ns	250 ns	200 ns
WIDE POWER BANDWIDTH	500 kHz	1,000 kHz	2,000 kHz
HIGH GAIN BANDWIDTH	12 MHz	12 MHz	20 MHz
HIGH INPUT IMPEDANCE	100 M Ω	100M Ω	100M Ω
LOW OFFSET CURRENT	10 nA	10 nA	10 nA
INTERNAL COMPENSATION	YES	YES	NO

PARAMETER	HIGH SLEW RATE												UNITS	
	PRECISION				COMPENSATED				UNCOMPENSATED					
	-55 to 125°C	-55 to 125°C	0 to 70°C	EPOXY 0 to 70°C	-55 to 125°C	-55 to 125°C	0 to 70°C	EPOXY 0 to 70°C	-55 to 125°C	-55 to 125°C	0 to 70°C	EPOXY 0 to 70°C		
OFFSET VOLTAGE	HA-2500	HA-2502	HA-2505	HA-2507	HA-2510	HA-2512	HA-2515	HA-2517	HA-2520	HA-2522	HA-2525	HA-2527	UNITS	
OFFSET VOLTAGE	2	4	4	5	4	5	5	5	4	5	5	5	mV	
BIAS CURRENT	100	125	125	125	100	125	125	125	100	125	125	125	nA	
VOLTAGE GAIN	30k	25k	25k	25k	15k	15k	15k	15k	15k	15k	15k	15k	V/V	
UNITY GAIN BANDWIDTH	12	12	12	12	12	12	12	12	20	20	20	20	MHz	
SLEW RATE	± 30	± 30	± 30	± 30	± 65	± 60	± 60	± 60	± 120	± 120	± 120	± 120	V/ μ s	
RISE TIME	25	25	25	25	25	25	25	25	25	25	25	25	ns	

*VALUES GIVEN ARE TYPICAL AT 25°C.



HA-2600 WIDE BAND, HIGH IMPEDANCE OPERATIONAL AMPLIFIERS

The Harris HA-2600/2620 series of operational amplifiers feature very high input impedance, coupled with wideband ac performance.

Low offset voltage, low bias and offset currents, together with high resistance input, facilitate accurate signal processing.

Complementing the input characteristics is excellent dynamic performance, making these amplifiers ideal for high-gain amplification of fast, wide band signals.

All amplifiers in this series—HA-2600 through

HA-2627—are available in the TO-99 metal can, 8-pin dual-in-line ceramic, or 8-pin dual-in-line epoxy packages.

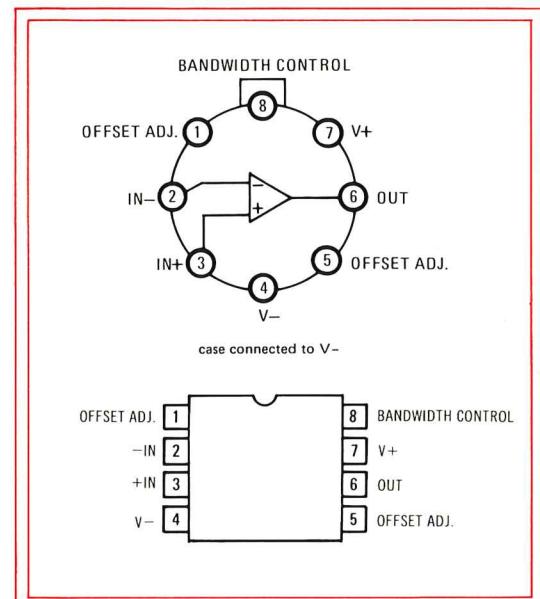
APPLICATIONS

- Video and RF Amplifiers
- Pulse Amplifier
- Audio Amplifiers and Filters
- High-Q Active Filters
- High-Speed Comparators
- Low Distortion Oscillators

PERFORMANCE FEATURES	HA-2600, HA-2602, HA-2620, HA-2622, HA-2605, HA-2607	HA-2625, HA-2627
GAIN BANDWIDTH PRODUCT	12 MHz ($A_V=1$)	100 MHz ($A_V=5$)
HIGH INPUT IMPEDANCE	500 M Ω	500 M Ω
LOW INPUT BIAS CURRENT	1 nA	1 nA
LOW INPUT OFFSET CURRENT	1 nA	1 nA
LOW INPUT OFFSET VOLTAGE	0.5 mV	0.5 mV
HIGH GAIN	150 kV/V	150 kV/V
HIGH SLEW RATE	7 V/ μ s	35 V/ μ s
OUTPUT SHORT CIRCUIT PROTECTION	YES	YES
INTERNAL COMPENSATION	YES	NO

PARAMETER*	WIDE BANDWIDTH								UNITS	
	COMPENSATED				UNCOMPENSATED					
	-55 to +125°C	-55 to +125°C	0 to 75°C	EPOXY 0 to 75°C	-55 to +125°C	-55 to +125°C	0 to 70°C	EPOXY 0 to 70°C		
PARAMETER*	HA-2600	HA-2602	HA-2605	HA-2607	HA-2620	HA-2622	HA-2625	HA-2627	UNITS	
OFFSET VOLTAGE	0.5	3	3	4	0.5	3	3	4	mV	
BIAS CURRENT	1	15	5	5	1	5	5	5	nA	
VOLTAGE GAIN	150k	150k	150k	150k	150k	150k	150k	150k	V/V	
UNITY GAIN BANDWIDTH	12	12	12	12	100	100	100	100	MHz	
SLEW RATE	± 7	± 7	± 7	± 7	± 35	± 35	± 35	± 35	V/ μ s	
RISE TIME	30	30	30	30	17	17	17	17	ns	

*VALUES GIVEN ARE TYPICAL AT 25°C.



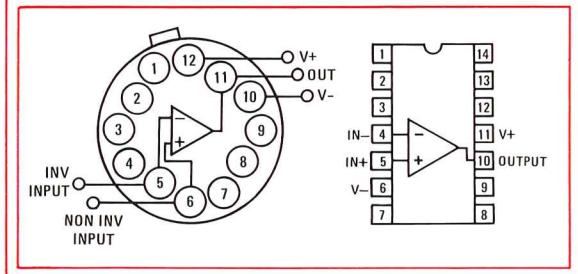
HA-5190 FAST SETTLING AMPLIFIER

The Harris HA-5190 and HA-5195 are monolithic operational amplifiers featuring an ultimate combination of speed, bandwidth and precision. These truly differential amplifiers are designed to operate at gains ≥ 5 without the need for external compensation, and are capable of delivering 200 V/ μ s slew rate with a settling time of 70 ns (0.1%, 5 V output step).

APPLICATIONS

- Fast, Precise D/A Converters
- High-Speed Sample-and-Hold Circuits
- Pulse Amplifiers
- Wideband Amplifiers

NEW



PERFORMANCE FEATURES

HA-5190, HA-5195

FAST SETTLING	70 ns
UNPARALLELED SLEW RATE	200 V/ μ s
WIDE GAIN BANDWIDTH	150 MHz
POWER BANDWIDTH	6.5 MHz
LOW OFFSET VOLTAGE	5 mV
INPUT VOLTAGE NOISE	15 nV/ $\sqrt{\text{Hz}}$
MONOLITHIC BIPOLAR CONSTRUCTION	

HA-5100 FET INPUT OPERATIONAL AMPLIFIERS

Harris HA-5100/5110 series devices are monolithic, wide band operational amplifiers manufactured with FET/Bipolar technologies and Dielectric Isolation. Precision laser trimming of the input stage complements the amplifier high-frequency capabilities with excellent input characteristics.

APPLICATIONS

- Precision, High-Speed, Data Acquisition Systems
- Precise Signal Generation
- Pulse Amplification

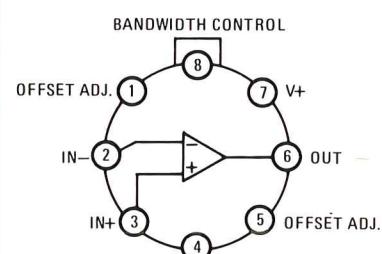
NEW

PERFORMANCE FEATURES:

HA-5100 HA-5105 HA-5110 HA-5115 HA-5150* HA-5160* UNITS

LOW INPUT OFFSET VOLTAGE	1.0	1.5	1.0	1.5	1.0	1.0	mV
LOW OFFSET DRIFT	5	15	5	15	10	10	μ V/ $^{\circ}$ C
LOW INPUT BIAS CURRENT	50	100	50	100	50	50	pA
LARGE VOLTAGE GAIN	150k	100k	150k	100k	150k	150k	V/V
WIDE BANDWIDTH	18	18	60	50	50	100	MHz
HIGH SLEW RATE	8	8	50	40	60	140	V/ μ s
FAST LARGE SIGNAL SETTLING TIME	1.7	2.0	0.85	1.0	0.7	0.5	μ s

*To be introduced.



HA-2700 LOW POWER OPERATIONAL AMPLIFIERS

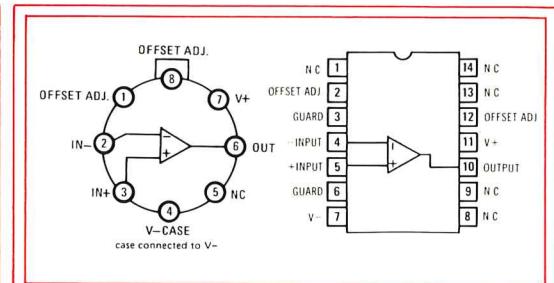
Harris HA-2700, HA-2704 and HA-2705 are internally compensated operational amplifiers which offer excellent dc and dynamic performance with very low quiescent power consumption.

APPLICATIONS

- High-Gain Amplifiers
- Instrumentation
- Amplifiers

- Active Filters
- Telemetry Systems
- Battery-Powered Equipment

PERFORMANCE FEATURES	HA-2700, HA-2704, HA-2705
LOW POWER DISSIPATION	2.24 mW at ± 15.0 V
HIGH SLEW RATE	20 V/ μ s
HIGH OPEN-LOOP GAIN	300 k (RL = 2 k and CL = 100 pF)
LOW INPUT BIAS CURRENT	5 nA
LOW OFFSET VOLTAGE	0.5 mV
HIGH CMRR	106 dB
WIDE POWER SUPPLY RANGE	± 5.5 V to ± 20.0 V



DUALS

HA-2650 DUAL HIGH-PERFORMANCE OPERATIONAL AMPLIFIER

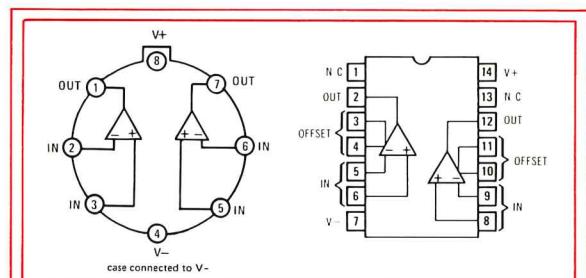
The Harris HA-2650/55 contains two internally-compensated operational amplifiers offering high slew rate and high frequency performance, combined with exceptional dc characteristics.

APPLICATIONS

- Video Amplifiers
- High Impedance, Wideband Buffers

- Integrators
- Audio Amplifiers
- Active Filters

PERFORMANCE FEATURES	HA-2650, HA-2655
SLEW RATE	5 V/ μ s
BANDWIDTH	8 MHz
BIAS CURRENT	35 nA
AVERAGE OFFSET VOLTAGE DRIFT	8 μ V/ $^{\circ}$ C
POWER CONSUMPTION	75 mW
SUPPLY VOLTAGE RANGE	± 2 V to ± 20 V



HA-2730 WIDE-RANGE, DUAL PROGRAMMABLE OPERATIONAL AMPLIFIER

Harris HA-2730 and HA-2735 Dual Programmable Amplifiers are internally-compensated devices offering a wide range of performance that can be controlled by adjusting the circuits' "set" current (I_{SET}). By adjusting an external resistor or current source, power dissipation, slew rate, bandwidth, output current and input noise can

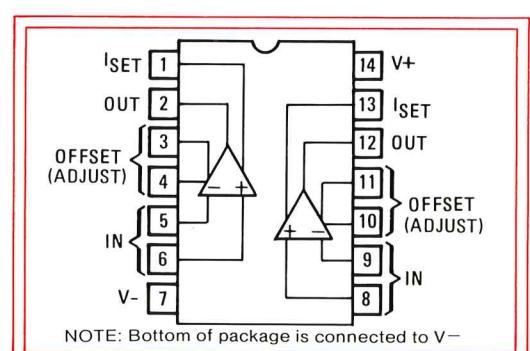
be programmed to desired levels. Each amplifier can be adjusted independently.

APPLICATIONS

- Active Filters
- Current-Controlled Oscillators

- Variable Active Filters
- Modulators
- Battery-Powered Equipment

PERFORMANCE FEATURES	HA-2730, HA-2735
•WIDE PROGRAMMING RANGE:	
SET CURRENT	0.1 to 100 μ A
SLEW RATE	0.06 to 6 V/ μ s
BANDWIDTH	5 kHz to 10 MHz
BIAS CURRENT	0.4 to 50 nA
SUPPLY CURRENT	1 μ A to 1.5 mA
•WIDE POWER SUPPLY RANGE	+1.2 to +18 V
•CONSTANT AC PERFORMANCE OVER SUPPLY RANGE	



PRAM™ FOUR-CHANNEL PROGRAMMABLE AMPLIFIER

The Harris HA-2400, HA-2404 and HA-2405 comprise a series of four-channel programmable amplifiers providing a level of versatility unmatched by other monolithic operational amplifiers. Versatility is achieved by employing four input amplifier channels, any one (or none) of which may be electronically selected and connected to a single output stage through DTL/TTL compatible address inputs. The device formed by the output and the selected pair of inputs is an Op Amp which offers excellent slew rate, gain bandwidth and power bandwidth performance.

APPLICATIONS

Among thousands of possible new applications are:

- Program Signal Selection/Multiplexing
- Op Amp Gain
- Oscillator Frequency
- Filter Characteristics
- Add-Subtract Functions
- Integrator Characteristics
- Comparator Levels

PERFORMANCE FEATURES

HA-2400, HA-2404, HA-2405

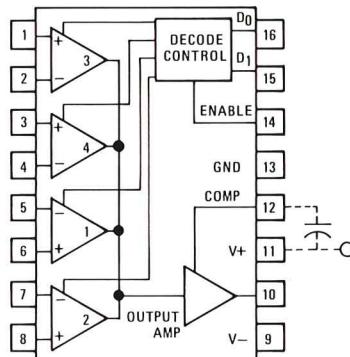
PROGRAMMABILITY

HIGH SLEW RATE
WIDE GAIN BANDWIDTH
HIGH GAIN
LOW OFFSET CURRENT
HIGH INPUT IMPEDANCE
SINGLE CAPACITOR COMPENSATION
DTL/TTL COMPATIBLE INPUTS

30 V/ μ s
40 MHz
150,000
5 nA
30 M Ω

TRUTH TABLE

D ₁	D ₀	EN	SELECTED CHANNEL
L	L	H	1
L	H	H	2
H	L	H	3
H	H	H	4
X	X	L	NONE



HIGH-PERFORMANCE QUAD OPERATIONAL AMPLIFIERS

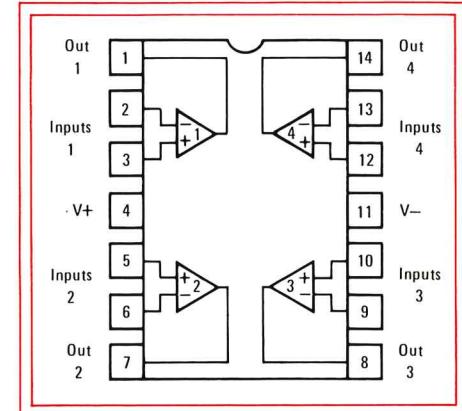
The Harris HA-4602/05/22/25 series of operational amplifiers offer wide bandwidth, high slew rate, and fast settling time specifications, complemented by low input offset voltage, low drift and low noise voltage.

True high-performance quads, these devices are suitable for a variety of applications including active filters, audio and instrumentation amplifiers.

APPLICATIONS

- High-Q, Wide Band Filters
- Instrumentation Amplifiers
- Audio Amplifiers
- Data Acquisition Systems
- Integrators
- Absolute Value Circuits
- Tone Detectors
- Pulse Amplifiers
- Video and RF Amplifiers

PERFORMANCE FEATURES	HA-4602, HA-4605	HA-4622, HA-4625
LOW OFFSET VOLTAGE	0.3 mV	0.3 mV
HIGH SLEW RATE	$\pm 4 \text{ V}/\mu\text{s}$	$\pm 20 \text{ V}/\mu\text{s}$
WIDE BANDWIDTH	8 MHz	70 MHz
LOW DRIFT	$2 \mu\text{V}/^\circ\text{C}$	$2 \mu\text{V}/^\circ\text{C}$
FAST SETTLING TIME (0.01%, 10 V STEP)	4.2 μs	2.5 μs
LOW POWER CONSUMPTION	35 mW/A	35 mW/A
SUPPLY RANGE	$\pm 5 \text{ V}$ to $\pm 20 \text{ V}$	$\pm 5 \text{ V}$ to $\pm 20 \text{ V}$



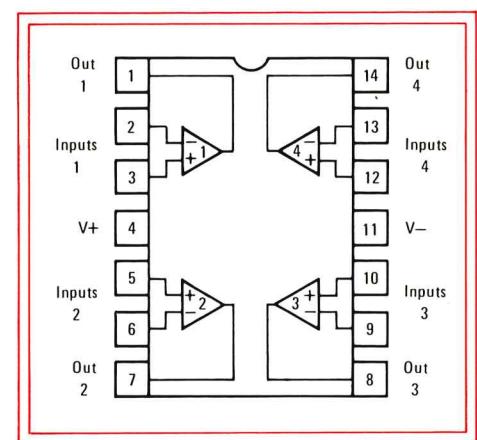
HA-4741 QUAD OPERATIONAL AMPLIFIER

The Harris HA-4741 device contains four amplifiers on a monolithic chip, providing a new measure of performance for general-purpose operational amplifiers. Each amplifier in the HA-4741 has operating specifications that equal or exceed those of the 741-type amplifier in all categories of performance.

APPLICATIONS

- Universal Active Filters
- D3 Communications Filters
- Audio Amplifiers
- Battery-Powered Equipment

PERFORMANCE FEATURES	HA-4741
SLEW RATE	1.6 $\text{V}/\mu\text{s}$
BANDWIDTH	3.5 MHz
INPUT VOLTAGE NOISE	9 nV/ $\sqrt{\text{Hz}}$
INPUT OFFSET VOLTAGE	0.5 mV
INPUT BIAS CURRENT	60 nA
SUPPLY RANGE	$\pm 2 \text{ V}$ to $\pm 20 \text{ V}$
NO CROSSOVER DISTORTION	
STANDARD QUAD PINOUT	



SPECIAL-PURPOSE AMPLIFIERS

HA-2530 HIGH SLEW RATE, INVERTING AMPLIFIER

The Harris HA-2530 and HA-2535 are monolithic, high-speed inverting amplifiers which deliver superior slew rate, bandwidth and accuracy specifications. These devices need no external compensation at closed-loop gains greater than 10. Operation to unity gain is possible with external compensation.

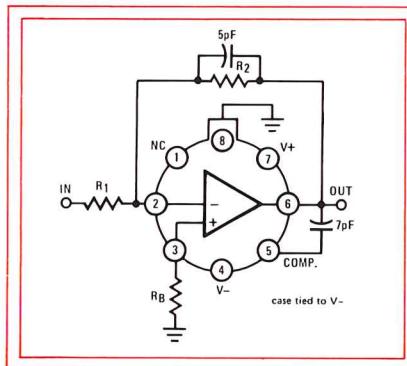
PERFORMANCE FEATURES

HA-2530, HA-2535

HIGH SLEW RATE	$\pm 320 \text{ V}/\mu\text{s}$
FAST SETTLING TIME	550 ns
WIDE POWER BANDWIDTH	5 MHz
HIGH GAIN BANDWIDTH PRODUCT	70 MHz
LOW OFFSET VOLTAGE	0.8 mV
LOW POWER SUPPLY CURRENT	3.5 mA

APPLICATIONS

- Pulse Amplification
- Signal Conditioning
- Signal Generators
- Coaxial Cable Drivers
- Integrators



HA-2630 HIGH-PERFORMANCE CURRENT BOOSTER

The Harris HA-2630 and HA-2635 are monolithic, unity voltage gain, current amplifiers featuring extremely high slew rate, wide bandwidth and full power bandwidth while driving large output loads. They are intended to be used in series with an operational amplifier and inside the feedback loop whenever additional output current is required.

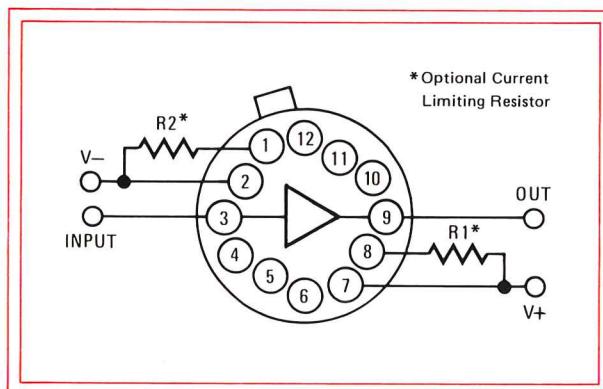
PERFORMANCE FEATURES

HA-2630, HA-2635

OUTPUT CURRENT	$\pm 400 \text{ mA}$
SLEW RATE	$500 \text{ V}/\mu\text{s}$
BANDWIDTH	8 MHz
FULL POWER BANDWIDTH	8 MHz
INPUT RESISTANCE	$2.0 \times 10^6 \Omega$
OUTPUT RESISTANCE	2.0Ω
POWER SUPPLY RANGE	$\pm 5 \text{ V}$ to $\pm 20 \text{ V}$
PACKAGE IS ELECTRICALLY ISOLATED	

APPLICATIONS

- Coaxial Cable Drivers
- Audio Output Amplifiers
- Servo Motor Drivers
- Power Supplies (Bipolar)
- Precision Data Recording



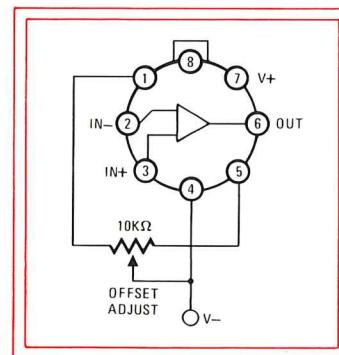
HA-2640 HIGH-VOLTAGE OPERATIONAL AMPLIFIER

The Harris HA-2640 and HA-2645 are monolithic operational amplifiers which are designed to deliver unprecedented dynamic specifications for a high-voltage, internally compensated device. These devices offer very low values for offset voltage and current, coupled with large output voltage swing.

PERFORMANCE FEATURES	HA-2640, HA-2645
OUTPUT VOLTAGE SWING	± 35 V
SUPPLY VOLTAGE	± 10 V to ± 40 V
OFFSET CURRENT	5 nA
BANDWIDTH	4 MHz
SLEW RATE	5 V/ μ s
COMMON MODE INPUT VOLTAGE SWING	± 35 V
OUTPUT OVERLOAD PROTECTION	

APPLICATIONS

- Industrial Control Systems
- Power Supplies
- High Voltage Regulators
- Resolver Excitation
- Signal Conditioning



HA-2720 WIDE-RANGE PROGRAMMABLE OPERATIONAL AMPLIFIER

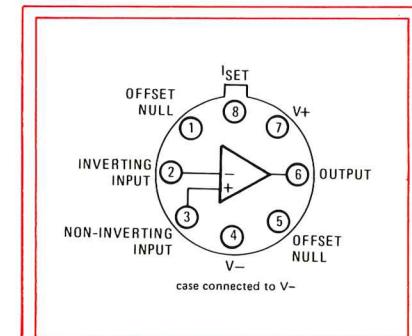
Harris HA-2720 and HA-2725 programmable amplifiers are internally-compensated monolithic devices offering a wide range of performance that can be controlled by adjusting the circuits' "set" current (I_{SET}). By adjusting an external resistor or current source, power dissipation, slew rate, bandwidth, output current and input noise can

PERFORMANCE FEATURES	HA-2720, HA-2725
WIDE PROGRAMMING RANGE:	
SLEW RATE	0.06 to 6 V/ μ s
BANDWIDTH	5 kHz to 10 MHz
BIAS CURRENT	0.4 to 50 nA
SUPPLY CURRENT	1 μ A to 1.5 mA
WIDE POWER SUPPLY RANGE	± 1.2 to ± 18 V
CONSTANT AC PERFORMANCE OVER SUPPLY RANGE	

be programmed to desired levels.

APPLICATIONS

- Active Filters
- Current Controlled Oscillators
- Variable Active Filters
- Modulators
- Battery-Powered Equipment



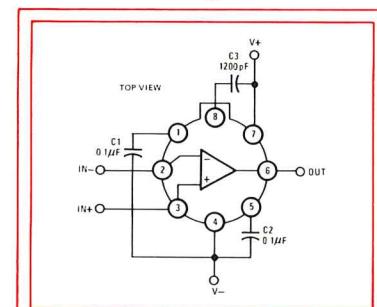
HA-2900 CHOPPER-STABILIZED OPERATIONAL AMPLIFIER

The Harris HA-2900, HA-2904 and HA-2905 are monolithic, chopper-stabilized amplifiers that achieve excellent offset drift, input currents and ac performance.

PERFORMANCE FEATURES	HA-2900, HA-2904, HA-2905
OFFSET VOLTAGE	80 μ V
OFFSET CURRENT DRIFT	1 pA/ $^{\circ}$ C
OPEN-LOOP GAIN	5×10^8
BANDWIDTH	3 MHz
SLEW RATE	2.5 V/ μ s
TRUE DIFFERENTIAL INPUTS	

APPLICATIONS

- High-Gain Dc Instrumentation
- High-Accuracy Weighing Equipment
- Biomedical Amplifiers
- Precision Integrators and Timers



SELECTION GUIDE

HIGH SLEW RATE AMPLIFIERS

PARAMETER	HA-2500	HA-2502	HA-2505	HA-2507	HA-2510	HA-2512	HA-2515	HA-2517	HA-2520	HA-2522	HA-2525	HA-2527	UNITS
INPUT CHARACTERISTICS													
Offset Voltage	8	10	10	14	11	14	14	14	11	14	14	14	mV
Drift (Typ)	20	20	20	25	20	25	30	30	20	25	20	30	µV/°C
Bias Current	400	500	500	500	400	500	500	500	400	500	500	500	nA
Offset Current	50	100	100	100	50	100	100	100	50	100	100	100	nA
Common Mode Range	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	V
TRANSFER CHARACTERISTICS													
Large Signal Voltage Gain	15k	10k	10k	10k	7.5k	5k	V/V						
Common Mode Rejection Ratio	80	74	74	74	80	74	74	74	80	74	74	74	dB
Bandwidth (Typ) (1)	12	12	12	12	12	12	12	12	25	25	25	20	MHz
OUTPUT CHARACTERISTICS													
Output Voltage Swing	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	V
Output Current (1)	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	mA
Full Power Bandwidth (Typ) (1)	500	500	500	500	1000	1000	1000	1500	1500	1500	1500	1500	kHz
TRANSIENT RESPONSE													
Rise Time (1)	50	50	50	50	50	50	50	50	50	50	50	50	ns
Overshoot (1)	40	50	50	50	40	50	50	50	40	50	50	50	%
Slew Rate (1)	±25	±20	±20	±15	±50	±40	±40	±30	±100	±80	±80	±60	V/µs
Settling Time (Typ) (1)	0.33	0.33	0.33	0.33	0.25	0.25	0.25	0.25	0.20	0.20	0.20	0.20	µs
POWER SUPPLY CHARACTERISTICS													
Supply Current (1)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	mA
Power Supply Rejection Ratio	80	74	74	74	80	74	74	74	80	74	74	74	dB
FUNCTIONAL CHARACTERISTICS													
Offset Adjustment	YES												
Compensation Components	0	0	0	0	0	0	0	0	OAV>3	OAV>3	OAV>3	OAV>3	
Output Protection	NO												
Temperature Range*	(A)	(A)	(B)	(B)	(A)	(A)	(B)	(B)	(A)	(B)	(B)	(B)	

FOOTNOTES: (1) At +25°C. (2) Not applicable or not specified. (3) Dependent upon I_{SET} value.

*Temperature Range: (A) -55°C to +125°C (B) 0°C to +75°C (C) -25°C to +85°C

Note: Parameters are minimum or maximum over temperature unless otherwise noted.

PARAMETER	HA-2600	HA-2602	HA-2605	HA-2607	HA-2620	HA-2622	HA-2625	HA-2627	UNITS
INPUT CHARACTERISTICS									
Offset Voltage	6	7	7	8	6	7	7	8	mV
Drift (Typ)	5	5	5	5	5	5	5	5	µV/°C
Bias Current	30	60	40	50	35	60	40	50	nA
Offset Current	30	60	40	50	35	60	40	50	nA
Common Mode Range	±11	±11	±11	±10	±11	±11	±11	±10	V
TRANSFER CHARACTERISTICS									
Large Signal Voltage Gain	70k	60k	70k	60k	70k	60k	70k	60k	V/V
Common Mode Rejection Ratio	80	74	74	74	80	74	74	74	dB
Bandwidth (Typ) (1)	12	12	12	12	100	100	100	100	MHz
OUTPUT CHARACTERISTICS									
Output Voltage Swing	±10	±10	±10	±10	±10	±10	±10	±10	V
Output Current (1)	±15	±10	±10	±10	±10	±10	±10	±10	mA
Full Power Bandwidth (Typ) (1)	75	75	75	75	600	600	600	600	kHz
TRANSIENT RESPONSE									
Rise Time (1)	60	60	60	60	45	45	45	45	ns
Overshoot (1)	40	40	40	40	40	40	40	40	%
Slew Rate (1)	±4	±4	±4	±4	±25	±20	±20	±17	V/µs
Settling Time (Typ) (1)	1.5	1.5	1.5	1.5	0.30	0.30	0.30	0.30	µs
POWER SUPPLY CHARACTERISTICS									
Supply Current (1)	3.7	4.0	4.0	4.0	3.7	4.0	4.0	4.0	mA
Power Supply Rejection Ratio	80	74	74	74	80	74	74	74	dB
FUNCTIONAL CHARACTERISTICS									
Offset Adjustment	YES								
Compensation Components	0	0	0	0	OAV>5	OAV>5	OAV>5	OAV>5	
Output Protection	YES								
Temperature Range*	(A)	(A)	(B)	(B)	(A)	(A)	(B)	(B)	

FOOTNOTES: (1) At +25°C. (2) Not applicable or not specified. (3) Dependent upon I_{SET} value.

*Temperature Range: (A) -55°C to +125°C (B) 0°C to +75°C (C) -25°C to +85°C

PARAMETER	FET INPUT AMPLIFIERS							FAST SETTLING AMPLIFIER		UNITS
	HA-5100	HA-5105	HA-5110	HA-5115	HA-5150†	HA-5160†	HA-5190	HA-5195		
INPUT CHARACTERISTICS										
Offset Voltage	2.0	3.5	2.0	3.5	2.0	2.0	10	10	mV	
Drift (Typ)	10	15	10	15	10	10	20	20	µV/°C	
Bias Current	10	20	10	20	10	10	20 µA	20 µA	nA	
Offset Current	5	10	5	10	5	5	6 µA	6 µA	nA	
Common Mode Range	±10	±10	±10	±10	±10	±10	±5	±5	V	
TRANSFER CHARACTERISTICS										
Large Signal Voltage Gain	60k	40k	60k	40k	50k	50k	5k	5k	V/V	
Common Mode Rejection Ratio	86	80	86	80	86	86	74	74	dB	
Bandwidth (Typ) (1)	18	18	60	50	50	100	150	150	MHz	
OUTPUT CHARACTERISTICS										
Output Voltage Swing	±12	±11	±12	±11	±10	±10	±5	±5	V	
Output Current (1)	±10	±8	±10	±8	±10	±10	±25	±25	mA	
Full Power Bandwidth(Typ)(1)	100	80	800	625	750	5,000	6,500	6,500	kHz	
TRANSIENT RESPONSE										
Rise Time (1)	15	20	20	20	15	15	11	11	ns	
Overshoot (1)							8	8	%	
Slew Rate (1)	±6	±5	±35	±35	±60	±120	±200	±200	V/µs	
Settling Time (Typ) (1)	1.7	2.0	0.85	1.0	0.7	0.5	0.1	0.1	µs	
POWER SUPPLY CHARACTERISTICS										
Supply Current (1)	7	8	7	8	7	7	33	33	mA	
Power Supply Rejection Ratio	86	80	86	80	86	86	70	70	dB	
FUNCTIONAL CHARACTERISTICS										
Offset Adjustment	YES	YES	YES	YES	YES	YES				
Compensation Components	0	0	0AV>10	0AV>10	0	0AV>10	0AV>5	0AV>5		
Output Protection	YES	YES	YES	YES	YES	YES	NO	NO		
Temperature Range*	(A) (B)	(B)	(A) (B)	(B)	(A)	(B)	(A)	(B)		

FOOTNOTES: (1) At +25°C. (2) Not applicable or not specified. (3) Dependent upon I_{SET} value.

* Temperature Range: (A) -55°C to +125°C (B) 0°C to +75°C (C) -25°C to +85°C

† To be introduced.

Note: Parameters are minimum or maximum over temperature unless otherwise noted.

PARAMETER	LOW POWER AMPLIFIER				DUAL HIGH PERFORMANCE AMPLIFIERS				UNITS	
	HA-2700	HA-2704	HA-2705	HA-2650	HA-2655	HA-2730	HA-2735	(3)		
INPUT CHARACTERISTICS										
Offset Voltage	5	6	7	5	7	5	7		mV	
Drift (Typ)	5	5	5	8	8	8 to 10	8 to 10		µV/°C	
Bias Current	50	50	70	200	300	10 to 40	10 to 40		nA	
Offset Current	30	30	40	60	100	7.5 to 20	7.5 to 20		nA	
Common Mode Range	±11	±11	±11	±13	±13	±10	±10		V	
TRANSFER CHARACTERISTICS										
Large Signal Voltage Gain	100k	100k	100k	20k	15k	25k	20k		V/V	
Common Mode Rejection Ratio	86	86	80	80	74	80	74		dB	
Bandwidth (Typ) (1)	1	1	1	8	8	.01 to 10	.01 to 10		MHz	
OUTPUT CHARACTERISTICS										
Output Voltage Swing	±11	±11	±11	±13	±13	±13.5	±13.5		V	
Output Current (1)	±22	±22	±22	±20	±18	±0.5 to 5	±0.5 to 5		mA	
Full Power Bandwidth(Typ)(1)	50	50	50	30	30	1.5 to 80	1.5 to 80		kHz	
TRANSIENT RESPONSE										
Rise Time (1)	(2)	(2)	(2)	40	40	200 to 2,000	200 to 2,000		ns	
Overshoot (1)	(2)	(2)	(2)	15	15	5 to 15	5 to 15		%	
Slew Rate (1)	±10	±10	±10	±2	±2	0.1 to 0.8	0.1 to 0.8		V/µs	
Settling Time (Typ) (1)	5.0	5.0	5.0	1.5	1.5	(2)	(2)		µs	
POWER SUPPLY CHARACTERISTICS										
Supply Current (1)	0.15	0.15	0.15	3	4	0.02 to 0.2	0.02 to 0.2		mA	
Power Supply Rejection Ratio	86	86	80	80	74	80	76		dB	
FUNCTIONAL CHARACTERISTICS										
Offset Adjustment	YES	YES	YES	DIP Only	DIP Only	YES	YES			
Compensation Components	0	0	0	0	0	0	0			
Output Protection	YES	YES	YES	YES	YES	YES	YES			
Temperature Range*	(A)	(C)	(B)	(A)	(B)	(A)	(B)			

FOOTNOTES: (1) At +25°C. (2) Not applicable or not specified. (3) Dependent upon I_{SET} value.

* Temperature Range: (A) -55°C to +125°C (B) 0°C to +75°C (C) -25°C to +85°C

SELECTION GUIDE

QUAD OPERATIONAL AMPLIFIERS

PARAMETER	HA-2400	HA-2404	HA-2405	HA-4602	HA-4605	HA-4622	HA-4625	HA-4741	HA-4741	UNITS
INPUT CHARACTERISTICS										
Offset Voltage	7	7	11	3.0	4.0	3.0	4.0	5.0	6.5	mV
Drift (Typ)	20	20	30	2	2	2	2	5	5	$\mu\text{V}/^\circ\text{C}$
Bias Current	400	400	500	325	400	325	400	325	400	nA
Offset Current	100	100	100	125	120	125	120	75	100	nA
Common Mode Range	± 10	± 10	± 10	± 12	± 12	V				
TRANSFER CHARACTERISTICS										
Large Signal Voltage Gain	25k	25k	25k	100k	75k	100k	75k	25k	15k	V/V
Common Mode Rejection Ratio	80	80	74	86	80	86	80	74	74	dB
Bandwidth (Typ) (1)	40	40	40	8	8	70	70	3.5	3.5	MHz
OUTPUT CHARACTERISTICS										
Output Voltage Swing	± 10	± 10	V							
Output Current (1)	± 20	± 20	± 20	± 10	± 8	± 10	± 8	± 5	± 5	mA
Full Power Bandwidth (Typ) (1)	500	500	500	60	60	150	130	25	25	kHz
TRANSIENT RESPONSE										
Rise Time (1)	20	20	20	50	50	38	38	75	75	ns
Overshoot (1)	25	25	25	30	30	45	45	25	25	%
Slew Rate (1)	± 30	± 30	± 30	± 4	± 4	± 12	± 11	± 1.6	± 1.6	$\text{V}/\mu\text{s}$
Settling Time (Typ) (1)	1.5	1.5	1.5	4.2	4.2	2.5	2.5	12	12	μs
POWER SUPPLY CHARACTERISTICS										
Supply Current (1)	6.0	6.0	6.0	5.5	6.5	4.6	5.0	5	7	mA
Power Supply Rejection Ratio	80	80	74	86	80	86	80	80	80	dB
FUNCTIONAL CHARACTERISTICS										
Offset Adjustment	NO	NO								
Compensation Components	0AV>10	0AV>10	0AV>10	0	0	0AV>10	0AV>10	0	0	
Output Protection	YES	YES								
Temperature Range*	(A)	(C)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	

FOOTNOTES: (1) At $+25^\circ\text{C}$. (2) Not applicable or not specified. (3) Dependent upon I_{SET} value.

* Temperature Range: (A) -55°C to $+125^\circ\text{C}$ (B) 0°C to $+75^\circ\text{C}$ (C) -25°C to $+85^\circ\text{C}$

Note: Parameters are minimum or maximum over temperature unless otherwise noted.

SPECIAL-PURPOSE AMPLIFIERS

PARAMETER	HA-2530	HA-2535	HA-2630	HA-2635	HA-2640	HA-2645	HA-2720	HA-2725	HA-2900	HA-2904	HA-2905	UNITS
INPUT CHARACTERISTICS												
Offset Voltage	3	5	300	300	6	7	5	7	.06	.05	.08	mV
Drift (Typ)	5	5	(2)	(2)	15	15	8 to 10	8 to 10	0.3	0.2	0.2	$\mu\text{V}/^\circ\text{C}$
Bias Current	100	200	200	200	50	50	10 to 40	10 to 40	1	1	1	nA
Offset Current	20	20	(2)	(2)	35	50	7.5 to 20	7.5 to 20	0.5	0.5	0.5	nA
Common Mode Range	± 0.5	± 0.5	(2)	(2)	± 35	± 35	± 10	± 10	± 10	± 10	± 10	V
TRANSFER CHARACTERISTICS												
Large Signal Voltage Gain	100k	100k	0.85	0.85	75k	75k	25k	20k	10^6	10^6	10^6	V/V
Common Mode Rejection Ratio	86	80	(2)	(2)	80	74	80	74	120	130	120	dB
Bandwidth (Typ) (1)	20	20	8	8	4	4	.01 to 10	.01 to 10	3	3	3	MHz
OUTPUT CHARACTERISTICS												
Output Voltage Swing	± 10	± 10	± 10	± 10	± 35	± 35	± 13.5	± 13.5	± 10	± 10	± 10	V
Output Current (1)	± 25	± 25	± 400	± 300	± 12	± 10	± 0.5 to 5	± 0.5 to 5	± 10	± 10	± 7	mA
Full Power Bandwidth (Typ) (1)	5,000	5,000	8,000	8,000	23	23	1.5 to 80	1.5 to 80	40	40	40	kHz
TRANSIENT RESPONSE												
Rise Time (1)	40	40	30	30	60	60	200 to 2,000	200 to 2,000	200	200	200	ns
Overshoot (1)	45	50	25	25	15	15	5 to 15	5 to 15	20	20	20	%
Slew Rate (1)	± 280	± 250	± 200	± 200	5	5	0.1 to 0.8	0.1 to 0.8	2.5	2.5	2.5	$\text{V}/\mu\text{s}$
Settling Time (Typ) (1)	0.5	0.5	0.5	0.5	1.5	1.5	(2)	(2)	(2)	(2)	(2)	μs
POWER SUPPLY CHARACTERISTICS												
Supply Current (1)	6	6	20	23	3.8	4.5	.02 to 0.2	.02 to 0.2	5	5	5	mA
Power Supply Rejection Ratio	86	80	66	66	80	74	80	76	120	130	120	dB
FUNCTIONAL CHARACTERISTICS												
Offset Adjustment	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO	
Compensation Components	1	1	0	0	0	0	0	0	3	3	3	
Output Protection	NO	NO	External	External	YES	YES	YES	YES	YES	YES	YES	
Temperature Range*	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(C)	(B)	

FOOTNOTES: (1) At $+25^\circ\text{C}$. (2) Not applicable or not specified. (3) Dependent upon I_{SET} value.

* Temperature Range: (A) -55°C to $+125^\circ\text{C}$ (B) 0°C to $+75^\circ\text{C}$ (C) -25°C to $+85^\circ\text{C}$

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